does not interfere with the up-spin transmission even after thermal treatment. Concretely, it is important that the material of the free layer does not form solid solution with the material of the nonmagnetic high-conductivity layer. For example, when the magnetic layer is of a Co alloy, then the nonmagnetic high-conductivity layer may be any of Cu, Au, and.

In view of the above, as one means of really preventing the MR characteristic degradation, it is important to dispose a metal material which does not form solid solution with the materials of the magnetic layers 1 and 2, at the both sides of the basic unit of the GMR film. In addition, for example, when a material of CoFe alloys and the like is used in forming the basic GMR unit, the insoluble metal material layer of that type must have an additional function as a seed layer capable of orienting the CoFe alloy layer in fcc(111)orientation. Therefore, it is understood that metal materials capable of readily orienting in fcc(111) orientation are preferred for the additional metal layers. Moreover, when the free layer is of a CoFe alloy, magnetostriction control in the layer is also important.

Another factor of the MR characteristic degradation in spin valve films in annealing is the change in the microstructure of the films in thermal treatment. The microstructure of spin valve films is one important factor for improving the thermal stability of the films. For this, the

microstructure of the films is desirably such that, in the basic GMR unit of free layer/nonmagnetic spacer layer/pinned magnetic layer, all interposing interfaces and the both outer interfaces could be kept stable even after thermal annealing. This is because the interface between free layer/nonmagnetic spacer layer and that between nonmagnetic spacer layer/pinned magnetic layer are both important for ensuring strong, spin-dependent interfacial scattering thereon, and because the both outer interfaces of the two magnetic layers are also important for thermally stabilizing the spin-independent specular reflection scattering thereon. Where the magnetic layers are of laminate films, the interface between the constituent magnetic films, one being adjacent to the nonmagnetic spacer layer while the other being adjacent to that one, shall be the specular reflection interface for spin-independent scattering thereon.

In order to realize the condition noted above, it is naturally desirable that the materials for magnetic layer/nonmagnetic layer are so selected that the material of the magnetic layer does not form solid solution with that of the nonmagnetic layer (for example, CoFe/Cu, or Co/Cu). On the interface of that type, the two materials do not form solid solution. Therefore, it is important to prevent atomic diffusion on the interface of magnetic layer/nonmagnetic layer and on the outer interface of the magnetic layer not adjacent

to the nonmagnetic spacer layer. For this, ideally, it is desirable that the crystals in the basic GMR unit moiety are single crystals. (In this connection, in one example of CoFe/Cu/CoFe, the constituent crystals do not differ so much in the lattice constant, and the crystal grains do not separately exist in each layer but form aggregated grains in the integrated constitution of CoFe/Cu/CoFe.) In fact, however, in the spin valve film 8 as formed on an amorphous layer of, for example, alumina or the like, single crystals are difficult to form.

Therefore, for practicable and realizable crystal structures, preferred are so-called pseudo-single-crystal film structures in which the intergranular boundaries, if any are not ordinary intergranular boundaries but are so-called sub-grain boundaries with little in-plane orientation gap. In the invention incorporating the MR-improving layer 4 noted above, spin valve films having small angle tilt boundaries of sub-grain boundaries are obtained and their reproducibility is high. Concretely, the spin valve films of the invention can be oriented in fcc(111) orientation, and the in-plane shift of the crystal orientation in the intergranular boundaries in the films could be limited within 30 degrees. The magnetoresistance effect characteristics of the spin valve films of the invention are greatly improved owing to the grain control in the films The crystal structures of the films will